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THE SALT INDUSTRY OF RAJPUTANA,

BY

F. ASHTON, Esq.,

Deputy Commissioner, Northern India Salt Revenue.

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Illustrated by

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W. GRIGGS,
Hanover Street, Peckham,
London, S.E.

The Journal of Indian Art and Industry.

THE SALT INDUSTRY OF RAJPUTANA.

By F. ASHTON, Esq., Deputy Commissioner, Northern India Salt Revenue.

The importance of the salt industry of Rajputana will be recognised, when it is mentioned that the sources of production furnish supplies of salt to five of the great territorial areas of India. The salt of Rajputana is in general use throughout the territory of that name, and it is extensively consumed in Central India and the North Western Provinces and Oudh. To the Panjab and the Central Provinces it is exported in lesser quantities, though the trade in it is of importance in connection with those areas also. The average production of Rajputana salt is about 200,000 tons annually, and it is consumed by about 59 millions of people.

In the Administrative nomenclature of the Indian Empire, the term Rajputana signifies a great territorial circle, which includes nineteen autonomous Native States with the British district of Ajmer in the centre. This territory lies between 23° and 30° north latitude and 69° 30′ and 78° 15′ east longitude, and the salt sources for which it is celebrated are situate in its north-western portion and north of the Aravali mountains. The character of this region is sandy, unproductive and badly watered. Between the Aravalis and the Luni (from *lûn*—salt) river, a stream which takes its rise near Ajmer and follows a south-westerly course until it reaches the Runn of Kutch, the country is comparatively fertile and well watered. But to the north and north-west of the Luni, which is flooded during the monsoon only and is merely a dry water-course at other seasons of the year, the country becomes more and more sandy and unproductive, with the water level falling deeper below the surface, until it merges into the Indian Desert, a vast area covered with interminable ridges of sand varying from 50 to 100 feet in height, and with the water level, where this can be reached, from 300 to 400 feet below the surface.

The whole of this area is saline in character. As a rule, the water obtained from wells is more or less brackish; in some instances so brackish as to be undrinkable by human beings, and in such cases the scanty population have to depend upon rain water stored in small reservoirs constructed underground. When depressions below the general surface level occur, salt effloresces profusely; and where these depressions are large, brine is obtainable for the production of salt. There are a number of depressions capable of producing salt, and the principal ones from which salt is at present obtained will now be described.

The most important of these salt sources is the Sambhar Salt Lake, which is situated in latitude 26° 58′ north and longitude 75° 5′ east, and at a height of about 1200 feet above the level of the sea. The lake is about 20 miles in length, with a breadth varying from two to seven miles, and with its major axis north-west to south-east; and it is about 60 miles in circumference and covers an area of about 90 square miles. The country surrounding it is sandy and sterile, with the Indian Desert to the westward. The more north-easterly spurs of the Aravali mountains, bare and barren peaks and ridges, intervene between the lake and the desert country, and it is this intervention which has served to protect the depression of the lake from being filled up with blown desert sand.

Local tradition relates that at one time a dense forest flourished on the plain now occupied by the lake. About the year 540 A.D., a Chohan Rajput, named Manik Rai, who lived in a village called Sirthulla on the margin of the depression, used to graze his cows in this forest, and observed one day that one of the animals returned home dry. Determined to discover the reason of this, he watched the cow the next day and found that she proceeded to the cave temple of the goddess mother Sakambri (the consort of Shiva) in a conical hill on the western edge of the plain, and there milked herself into the brass vessel of an ascetic who sat motionless at the shrine absorbed in contemplation of the Deity. Having conducted herself in this pious manner, the cow returned to the herd, but Manik Rai remained behind and stole up unperceived close to the holy man. After a while, the ascetic removed a charm from his mouth, and placing it on the ground, commenced drinking the milk. Manik Rai instantly picked up the amulet, and by its virtue visited in spirit the twenty-four sacred places of Hindu pilgrimage in a moment; and as soon as the ascetic had finished his draught, presented the charm. The holy man, now observing the stranger for the first time, was surprised at his honesty in returning the priceless amulet, and desired him to keep it. Manik Rai, however, refused, on which the ascetic directed him to present himself before the goddess, who would be kind to him. Obeying the ascetic, Manik Rai reverently approached the shrine, on which the goddess, instantly creating a horse, bade him mount and ride, but warned him to abstain from looking backwards. In accordance with this injunction, Manik Rai mounted and rode, taking a somewhat circular course, and as he passed along, the forest disappeared and the plain became covered with solid silver. By evening he had proceeded about 50 miles, when the branch of a tree having caught his turban, he turned to disentangle it, forgetting for a moment the goddess's prohibition; the horse stopped instantly and refused to go further. Manik Rai had no choice but to return home. As the sun arose next morning and displayed a vast plain of glittering silver, the inhabitants of the village of Sirthulla were awe-struck, and collecting in knots, sought fearfully from each other the meaning of the strange sight. Manik Rai then related his adventure of the previous day, on which the sages of the community determined that he should be deputed to the goddess to beg her to take back her gift, as it would assuredly be the cause of war and destruction to the village. Manik Rai accordingly approached the shrine and delivered the message. The goddess replied that from real silver the plain would be transformed into one of apparent silver, and it instantly became a vast sheet of water. The inhabitants of Sirthulla remained ignorant of the value of the lake till some time after, when a native officer of position in passing the lake noticed the formation of crystals of salt in the water, communicated its worth to them, and had himself placed in charge of the place in order that he might manufacture salt. A family now residing at the lake

claim to be the descendants of this personage; and judging from this tradition, the lake has been worked for salt during the past 1400 years.

The bed of the lake is composed of a fine, black, tenacious mud, very soft to a depth of about two feet from the surface, but gradually hardening at lower levels. It shelves very gradually towards the centre, the fall in 3·27 miles being only 2·08 feet. The lake has no outlet. The supply of water which enters it is derived from three rivers which empty themselves into it; two from the spurs of the Aravali hills to the westward, and the third and largest from the country to the north. During the hot and cold seasons, these rivers are dry, with salt efflorescence covering their beds, as the country they traverse is impregnated with salt; but during the annual rains they come down in flood and fill the lake to a depth of about four feet in the centre in a season of good rainfall. With this depth, the whole of the lake is covered with water. The rainfall varies greatly; during the past twenty-three years it has fluctuated between 40 and 10 inches annually, but the average fall is about 20 inches. Evaporation in the dry sandy country in which the lake is situate is extremely rapid, and in years of ordinary rainfall the whole of the water which accumulates during the rainy season is evaporated during the succeeding dry months, leaving a crust of salt on the lake bed. Occasionally, after an exceptionally heavy rainfall, the lake contains water throughout the year. During the rainy season, the scenery of the lake is exceptionally fine; a magnificent sheet of water (its shallowness is not apparent), with bold rocky hills to the westward, and the surrounding country clothed with grass of a tender green. But during the dry months, the country resumes its sterile appearance, and the bed of the lake, with its crust of salt, takes the appearance of a plain of white glittering snow.

The density of the lake brine varies with the annual accumulation of water. In a year of ordinary rainfall, it is about 3° Beaumé (the density of sea water) at the close of the rainy season in September; occasionally, when the lake is exceptionally full, it is less; and during years of drought, when the rivers come down in slight flood only, it is as much as 10° Beaumé. The salt in the brine appears to be derived from two sources. The surrounding country, the drainage of which falls into the lake, is saline, and during the annual rains a considerable quantity of salt is washed into the lake yearly. The principal source of supply seems, however, to be subterranean. A stratum of salt brine of high density underlies the bed of the lake at a depth of about 30 feet and under considerable pressure. Except during years of very heavy rainfall, the whole of the brine in the lake evaporates, leaving its bed exposed to a very high degree of solar heat in a peculiarly dry atmosphere. But though this happens, the mud of the lake bed always remains soft and wet, even during years of most severe drought. This is probably owing to the evaporation of the subterranean brine, and the salt in that brine is in such case drawn upwards by capillary attraction and remains in the soft mud on the surface of the lake bed. When the lake again fills and the water which has accumulated in it is agitated by the strong winds which prevail during the dry months, much of the salt in the surface mud is probably taken up in solution, and the visible supply of salt is thus renewed. Experience has shown that the brine is richer in chloride of sodium in years during which high winds blow, than in those during which the atmosphere is comparatively calm.

The lake lies within the boundaries of the Native States of Jaipur and Jodhpur. The western half lies within the Jodhpur State, and the eastern half is owned by both States jointly. The population in the neighbourhood of the lake is sparse owing to the sterility of the country, but there are two not inconsiderable towns on the shores of the lake itself; Sambhar (from which the lake takes its name), at the eastern end, with a population of about 12,000 inhabitants; and Nawa, on its north-western shore, with about 5,000 inhabitants. Both towns owe their importance to the trade in the salt of the lake. The town of Nawa lies within the Jodhpur State, but that of Sambhar, together with some villages in its vicinity, is the joint property of both Jodhpur and Jaipur. The State administration at Sambhar is a dual one; there are two chief magistrates, two police magistrates, and two officials of every rank, one half owing allegiance to Jodhpore and the other half to Jaipur. The revenue is shared equally between the two States, and it speaks well for the good feeling of the native officers that this joint administration can be carried on. The towns of Sambhar and Nawa arose to their present positions on three considerations—the existence of drinkable water in sufficiently large quantities, facilities for the manufacture of salt, and the lines of trade routes. At both Sambhar and Nawa the surface level of the country slopes somewhat steeply down to the lake, and a good supply of drinkable water is available in the higher strata of the soil. There is good water available on a part of the northern shore of the lake also, though in lesser quantity; but elsewhere, where the country bordering on the lake is low-lying, the water is brackish. The eastern end of the lake under the town of Sambhar is somewhat narrow and this affords facilities for manufacture which have been availed of from the earliest times. At Nawa also, the lake is somewhat narrow, and this circumstance, together with a supply of drinking water, permits of the advantageous production of salt. Finally, before the construction of railways, the two towns, which are about twenty miles apart, were adapted by their position for the supply of salt along different lines of traffic; those lines radiating to the south and east from Sambhar, and to the north-east and north from Nawa.

During the year 1870, in view to reducing the cost of Sambhar salt to the many millions of British subjects who consumed it, by improved methods of administration and facilitating the carriage of the salt to areas of consumption by the construction of a railway, the British Government obtained the lease of the lake from the Jodhpur and Jaipur States for an annual payment of ₨700,000 (equivalent to about £47,000), on the condition that if the sales of salt exceeded 1,725,000 maunds (equivalent to about 64,000 tons) in any year, forty per cent of the sale price of such excess would be paid to the States as royalty. The lake has therefore been in charge of British Officers for the past 29 years, and the methods of manufacture will now be described.

The monsoon rains, which cease during the month of September, are followed by about nine months of practically rainless weather, and in the dry atmosphere of that part of Rajputana, the brine of the lake rapidly increases in density and the production of salt is effected under the influence of solar heat. Salt is obtained by three methods: from permanent salt works constructed in the bed of the lake and called Kyars; from shallow

solar evaporation pans of a temporary nature constructed on the lake shore; and from enclosed sections of the lake bed on which salt forms, so to speak, spontaneously.

A Kyar is a salt work constructed in the bed of the lake by enclosing a rectangular space with an embankment of lake mud from five to seven feet in height, pitched with stone to protect it from the main body of lake water. Within the enclosure, large solar evaporation pans are excavated, with pathways between, and brine is run into these pans from the lake by gravitation to a depth of from twelve to sixteen inches. Evaporation by solar heat (and the heat at the lake during the summer months is intense and continuous) results in the precipitation of salt, which forms in a soft crust from two to three inches in thickness on the bed of a pan. When the salt is ready for extraction, and this occurs on the brine reaching a density of about 30° Beaumé, labourers enter a pan with baskets, the crust is broken up, and the salt, after being washed with the bittern, is carried to a storage platform by the side of the enclosure, and is there stored in oblong heaps, with their sides sloped to an angle of about 36 degrees and each containing about 2,000 tons. The salt produced is white and of very good quality. It forms in four-sided pyramids, lined with steppes, the crystals varying from half an inch to as much as an inch in length. It is curious that the best type of Sambhar salt, with the most perfect form of crystal, is obtained from a depth of about twelve inches of saturated brine with a density of 25° Beaumé; a greater or a lesser depth of brine results in the production of smaller and irregular crystals. A salt work of the type described permits of manufacture being carried on even when the lake is so full of brine that a sufficient area of the shore is not available for the production by other methods; the supply of brine for the pans can be so regulated and manufacture can be carried on in such a manner as to obtain the best description of salt the lake is capable of producing; and during a year of scanty rainfall, the pans in it can be filled for a full crop of salt before the small quantity of brine in the lake recedes towards its centre. There are at present eleven of these salt works at the lake; ten in the vicinity of the town of Sambhar at the eastern end, and one near Nawa on its north-western shore. The size of their rectangles varies from 1681 feet by 951 feet, to 4150 feet by 1446 feet. The smallest enclosure contains 20 solar evaporation pans, each 421 feet by 152 feet, and an evaporating surface of 28½ acres; the largest has 60 pans, each 670 feet by 200 feet, and an evaporating surface of 184½ acres. The entire evaporating surface of the eleven existing enclosures covers an area of nearly 736 acres, and during a good manufacturing season, with all conditions entirely favourable, their productive capacity is about 200 tons an acre. The bittern which remains in the pans of the enclosures is pumped out into the lake by centrifugal steam pumps, and at the close of a manufacturing season, the pans are cleaned out and prepared for the next year's crop.

When after the close of the rainy season, the brine of the lake begins to recede towards its centre, shallow solar evaporation pans about 100 feet in length by 50 feet in breadth are made along the line of the lake shore, by scraping aside the soft surface mud and with it enclosing rectangles with ridges of about a foot in height. Narrow channels are run from these pans to the water's edge, and the brine is lifted into them with the aid of slung baskets lined with skins and each worked by two men. The brine in the pans is kept at a depth of three or four inches until a sufficiency of salt has precipitated. The salt is scraped up by means of small pieces of plank attached to long handles, is placed in conical heaps near the pans, and is finally carried on carts and animals to storage grounds above high-water mark and there stored in oblong heaps similar to those in which the salt of the Kyars is placed, the quantity in each heap amounting to as much as about 4,000 tons. The salt produced in this manner is white and of good quality, but the crystals are small owing to the shallow depth of brine in which they are formed. During a favourable year, from 4,000 to 5,000 of these pans are worked and occupy a length of about 15 miles of the lake shore.

Marketable salt is obtained from the bed of the lake in the following manner. When the brine of the lake has reached a high specific gravity and is beginning to recede towards the lake centre, it is enclosed within sections of the lake bed by means of rough retaining walls from eighteen inches to two feet in height, built of double lines of stakes lined with grass (*Saccharum Sara*), and the space between, about two feet, filled with lake mud. The sections of the lake bed so enclosed are situated within easy distance of the shore, and where the retaining walls are not likely to be affected by the main body of water when this is agitated by storms and strong winds. The mud of the lake, even within a short distance of the shore, is as much as two feet in depth, and it is so soft that it is not practicable to collect salt in heaps except at places not far below high-water mark. Salt which forms in these enclosures has therefore to be carried by labourers in baskets to points on the shore where the ground is hard enough to admit of its being collected in quantity, and consequently it is not economical to work beyond a certain point in the lake bed, as the cost of carriage of salt by labourers increases in greater proportion than the distance traversed. In addition to this, though the water in the lake is shallow, its extent is so great that it has considerable force when agitated by strong winds, and retaining walls built beyond a certain distance from the shore are liable to be swept away. An enclosure of the kind described having been constructed, endeavour is made to maintain the brine in such quantity as will result in a depth of about twelve inches at saturation point (25° Beaumé), and this is done by admitting a fresh supply at intervals when the brine of the main lake is banked up against the enclosure by a favourable wind. When the salt is ready for removal, narrow pathways are made by placing layers of grass upon the soft mud of the lake bed, and these are used by labourers for entering the enclosure and leaving it with basket loads of salt. Within the enclosure, the men wade into the soft, black mud, carefully lift the crust of salt (which is from two to three inches in thickness) by placing their outspread fingers below it, and collect it in their baskets. In these, it is carried along the pathways already described to the nearest point where firm ground is available on the shore, and is there collected in conical heaps. It is finally conveyed on carts and animals to storage grounds above high-water mark, where it is stored in the same manner as the produce of the solar evaporation pans worked on the lake edge; in fact the same grounds are used for the storage of both descriptions of salt. This spontaneous salt is of good quality, and the crystals are similar in shape and size to those obtained from the Kyars, though the colour is not so white. During a

favourable season for manufacture, the parts of the lake bed enclosed in the manner described, cover in the aggregate about six square miles.

In the case of salt obtained from the Kyars and enclosed parts of the bed of the lake, its collection is effected by daily labour and the work is paid for from day to day. The labourers, as they collect the salt, form it into small pyramids, pouring it out of their baskets on the apex of each so as to obtain the correct angle of repose as nearly as possible. The size of these pyramids varies with the industry of different labourers, but the quantity of salt in them averages about five hundredweight. The quantity of salt in each pyramid is estimated by the measurement of the angle of repose (which is about 36°), and this is effected by means of a graduated rod marked so as to show at a glance the quantity of salt in a pyramid of a certain height and of a certain measurement along the slope of its side. The day's work having come to a close, the measurement of each pyramid is effected with the rod, the quantity is recorded by the officer supervising the estimation, and the wage due to the labourer for the work done is placed upon the pyramid, the apex of which is knocked off for the purpose. When manufacture is active about 4,500 persons are engaged in the collection of salt and daily payments are practicable only in the manner described. The salt collected each day is estimated, paid for and stored by evening, and each labourer returns to his home with the money which he has earned in his possession. The procedure followed is very popular. As soon as the collection of salt commences, labourers resort to the lake from long distances, and live in small huts erected in the vicinity of the salt works from materials (grass, &c.) given to them for the purpose. The collection of salt which forms in the Kyars is not unpleasant work, but in wading in the mud of the enclosed parts of the lake bed, the bare feet and legs of the labourers are often cut by salt crystals and festering sores occur. This, however, is not heeded, as payments are regular and liberal, and a man whose feet or legs have been affected takes up other work until he has recovered and then returns to collect salt.

During the hot season, the collection of salt begins with the dawn and ceases at about 10 or 11 a.m., as about the approach of midday the brine and mud of the lake become scalding hot, and no man dare enter the lake mud during the afternoon. Severe injuries have occurred through neglect of this precaution. The solar evaporation pans on the lake edge are worked by petty contractors, each man working a set of ten or twelve. The salt is estimated in the manner already described, but instead of each pyramid being paid for separately, one payment is made for the total quantity obtained from a pan, as in each case only one owner is concerned. Immediately after estimation, the salt obtained from the Kyars is at once thrown up into large store-heaps on platforms provided besides each of these salt works. The salt of the pans on the lake edge and that obtained from the lake bed, is collected on the firm ground of the shore nearest the places of production in conical heaps of about twenty tons each. From these it is removed on carts, pack buffaloes, bullocks, and donkeys to the storage grounds above high-water mark. All salt is stored in the open, and though it is thus exposed to the vicissitudes of the weather, the climate is so dry that the loss sustained from rainfall is not as great as it would be in moister atmosphere. The cost of the manufacture and storage of salt at the lake amounts to about 13 pence a ton. This does not, of course, take into account the sum paid for the lease of the lake, the cost of supervision, and the capital expenditure on the construction of salt works.

It will have been noticed that manufacture of salt at the lake is dependent upon the monsoon rainfall. This greatly varies from year to year, and the outturn of salt fluctuates in accordance with the quantity of brine in the lake. The greatest quantity produced in any one year has been about 260,000 tons, and during a year of excessively heavy rainfall only about 3,300 tons were obtained. The total quantity obtained during the past 29 years that the lake has been worked by the British Government amounts to more than $3\frac{1}{2}$ millions of tons. The quality of the salt is good, as it contains from about 96 to more than 98 per cent of chloride of sodium, and it is the favourite salt of the people who inhabit Rajputana, Central India, and the North-Western Provinces and Oudh.

Before a line of railway was extended to the lake, salt used to be conveyed to areas of consumption on carts, camels, and pack bullocks. Supplies taken to the north and east were conveyed over the sandy country on camels principally, while the pack bullocks of the wandering tribe of hereditary carriers named Banjaras were the means by which salt was carried into the then wild regions of Central India to the south and south-east. The Banjara trade of the lake was at one time of great importance. Droves of pack bullocks, numbering as many as 10,000, used to visit it, arriving with much ceremony, the principal man of each drove being mounted on a handsome horse and attended by an escort bearing a flag and kettledrums. These Banjaras were traders, carriers, and distributors combined; they purchased salt, conveyed to areas of consumption on their bullocks, and retailed it from town to town and from village to village. The extension of railways and the more settled and peaceful condition of all parts of the country has affected this description of trade; salt can be cheaply and expeditiously transported in all directions by railway, and the great droves of Banjara bullocks escorted by armed men are no longer to be seen anywhere. A few of these picturesque wanderers still visit the lake yearly, but the number is small, and as railways extend still further, this description of trade will cease. There are now great facilities for the removal of salt by railway from the lake direct to areas of consumption. The Sambhar branch of the Rajputana Malwa Railway runs to the town of Sambhar, crosses the eastern end of the lake on an embankment to its northern shore, a distance of about five miles, and then skirts that shore to the town of Nawa ten miles further on. All of the storage platforms of the Kyars in the bed of the lake, and the storage grounds on its edge, are connected with the main line of railway by sidings; the aggregate length of these latter is about fifteen miles, and bags filled from the heaps of salt can at once be placed in railway waggons standing within easy distance. The salt is sold at nine shillings a ton, and for a further payment of sevenpence a ton, the British Officers at the lake undertake to clear the salt by railway to any destination. This convenience is largely availed of. Traders resident in areas of consumption many hundreds of miles distant, pay the price and the small fee for clearance into the nearest Government treasury or post office and send the necessary empty bags to the lake, whence their

salt is sent to them expeditiously by railway. In Central India, the Indian Midland Railway also receives salt revenue in this manner at different railway stations, and the system conduces to the cheap distribution of salt, by which the consumer benefits. The salt of the lake is widely distributed. It is largely consumed in Rajputana, Central India and the North-Western Provinces and Oudh. It is exported into the Panjab and the Central Provinces, and is also consumed in the Himalayan State of Nepal.

The Sambhar lake, of which the writer was in charge for five years, is not a desirable place of residence. The country is arid, the heat great, and when the lake is drying up the stench from decaying insect and vegetable forms, which flourish when the brine is weak and die off as its density rises, is very offensive. But the scenery shortly after the rainy season is worth a visit. Standing on the low sand ridge at the eastern end of the lake, on which the salt officers have settled, the spectator would see below him the white buildings of the town of Sambhar, and beyond a vast sheet of water bounded to the westward by the hills and ridges of the Aravali range, with the white houses of the town of Nawa nestling in trees on the edge of the lake, about twelve miles away, in a direct line. Nearer, he would notice the railway line crossing the eastern end of the lake on a high embankment, the large salt works which have been described, snow-white heaps of salt of about 2000 tons each dotted here and there, and crowds of labourers engaged in the collection and storage of salt. He would also see thousands of flamingoes appearing like pink clouds as they rose in flight. These birds resort to the lake soon after the annual rainfall and live upon the insect life with which the lake teems while the density of the brine is low. They migrate as soon as the specific gravity of the lake increases and all insect and vegetable forms are destroyed by the rising density of the brine. There is, however, a reverse to this picture, as the appearance of the locality is very different during a season of drought. The monsoon rainfall of 1899 failed throughout Rajputana, which is suffering at the present from the most severe famine of the century. But little water entered the Sambhar lake and it is at present perfectly dry. It has not been possible to obtain salt from pans on the lake or from the lake bed, and but little brine could be taken into the Kyars. The country round the lake is at present desolate and a picture of sterility, and the stir and bustle usual on the lake works in connection with the collection of salt is wanting. Variations of this kind are to be looked for in the sandy portion of Rajputana where the rainfall is a very uncertain factor.

The Pachbadra salt source is situate in Jodhpur territory and is next in importance to the Sambhar lake as a salt-producing locality. Pachbadra is a small town of about 5,000 inhabitants. on the right bank of the Luni river, and at a distance of about 40 miles to the south-westward of the city of Jodhpur. The State of Jodhpur is also termed *Marwar*, the Land of Death, and the name is an appropriate one as regards the part of the country in which Pachbadra lies. The town is some distance from the Luni river, a dry water course with a bed of glaring sand, except during brief periods of the monsoon when it comes down in flood. The low-lying ground between the town and the river is waterless and sterile, while to the west and north the interminable sand hills and ridges of the Great Desert begin and extend over a vast area ; stretching about 200 miles westwards towards Sindh and to a greater distance northward to the Panjab.

Ten miles to the westward of the Luni river, and about two miles in the same direction from the town of Pachbadra, a large sandy valley takes its rise from the desert sand-hills and extends for a distance of about twelve miles, with a breadth varying from one and a half to two miles. It follows a south-westerly course parallel with the Luni for some miles, and then turns to the eastward and joins that river. The eastern edge of the valley is bounded by rising ground of hard soil, capped here and there by hills and ridges of blown sand, and sloping towards the Luni river ; while to the westward the sand-hills of the desert form one unbroken line. The origin of the valley is obscure, but it is possible that in post tertiary times an arm of the sea extended up the Luni valley to the neighbourhood of the city of Jodhpur, the Runn of Kutch being of course an inland sea, and that the valley in which the Pachbadra salt source is now situate was an inlet of the sea. The present height of Pachbadra above the sea is about 360 feet, and the sand of the desert can apparently only be satisfactorily explained by supposing that it was derived from a former coast line.

The Pachbadra salt source occupies a section of about 5¾ miles in length by 1¾ miles in breadth of the upper end of the valley. Under this area, brine springs exist, and it is from this brine that salt is manufactured. The springs are found in a bed of clay and nodules of carbonate of lime lying about 11 feet below the present surface, and excavations which have been made show clearly the past history of the valley. The stratum in which the brine springs occur is covered by a layer of coarse sand and gravel, and this was evidently the former bed of the depression. Above this there is a stratum of sand and clay ; then another of layers of sand, silt and salt crust ; above this a stratum of deposits of silt and desert sand with lines of washed sand and salt crust between ; and finally a surface stratum of blown desert sand. These indications go to show that in the past the bed of the valley was about 8½ feet below its present level ; that it was a salt marsh which was periodically inundated and in which salt formed during the dry season of each year ; and that it has been filled up to its present level by deposits of blown sand. Bounded as the depression is to the westward by a vast sea of desert sand, it would have been overwhelmed long ere this by advancing sand waves, but for the curious fact that the strong winds which prevail during the summer months blow from a south-westerly direction, and as these pass over comparatively hard ground in the vicinity of the Luni river, their effect in filling up the valley with sand has been comparatively slow. The present appearance of the upper part of the valley, where salt is manufactured, is that of a slightly undulating sandy plain on which clumps of *Salvadora olesides* occur here and there. Lower down the valley, the accumulation of sand is not as yet so great, and the general level is more uniform and barren. In this lower section also, brine is found below the surface, and formerly salt used to be made at two localities, but production is how confined to the upper part of the valley.

Local tradition in regard to the past history of the valley is in accordance with the illustrative indications afforded by excavation. It is related that in former times, when the country was more sparsely populated than it is even now, the bed of the valley was a saline marsh in which salt used to deposit during the dry and hot months

of the year, and the wild aboriginal tribes of the neighbourhood used to collect this salt for their own consumption and for sale to the inhabitants of the adjoining desert. About 400 years ago, a man named Pancha, a Jat (agriculturist) by caste, lived in and owned a small desert hamlet which stood upon the present site of the town of Pachbadra. That town takes its name from that of Pancha Jat, *Pancha-padra*, Pancha's fields, corrupted to Pachbadra. The story goes on to relate that a man of the Kharwal (salt manufacturing) caste named Jhanja had occasion to travel from his home in the Udaipur State, about 150 miles to the eastward, and visited Pancha's hamlet. He noticed the formation of salt in the bed of the marsh, and recognising the value of his discovery, settled down in the hamlet and commenced the systematic collection and sale of salt. He was joined by other Kharwals from the country to the eastward and it was in this manner that the present community of about 200 households of Kharwals in the town of Pachbadra took its rise. Several of these families claim descent from the original founder of their settlement, Jhanja Kharwal. For some time after they commenced to work in the salt marsh, Jhanja and his fellows contented themselves with collecting the salt which formed spontaneously in hollows here and there. At last, they discovered that brine springs existed not far from the surface and a small shallow pit was dug to the level of these. The result was satisfactory, as a better description of salt was obtained from the subterranean brine, and the collection of inferior spontaneous salt was abandoned. Later, it was discovered that the best crystals of salt formed upon the thorny branches of desert shrubs which were blown by accident into the pits. Experiments were made and it was found that the thorny twigs of the *Lycium Europæum* were best adapted for the purpose, as they did not decay in the salt brine and the long thorns facilitated the formation of large crystals.

The alleged discoveries of Jhanja and his brethren form the basis of the methods of manufacture which are followed at the present time. These methods are peculiar to the locality, and are so entirely adapted to local conditions that no improvement upon them has been found practicable. Pits of an average length of 230 feet, with their banks sloped to an angle of about 45 degrees, are dug in the bed of the valley to a depth of about eleven feet, until the subterranean springs of brine have been tapped, and these become filled to a depth of about three feet with strong brine varying in density from about 20° Beaumé to saturation point (25° Beaumé). To promote crystallization and to encourage the growth of large crystals, branches of the thorny *Lycium Europæum* (locally termed *Morali*) are thrown into the pits, just as the formation of an overset of salt indicates that precipitation has commenced, and are lightly packed in the brine. During the great heat of the months of April, May and June, and in the dry atmosphere of the desert, the evaporation of the brine exposed in an open pit is very rapid; and as this proceeds and salt is precipitated, more brine flows in, until the pit is filled to a depth of about three feet with salt. This formation is not complete for about two years, two hot seasons being necessary for the precipitation of all of the salt a pit is capable of containing up to the level to which the brine can rise. When the salt of a pit is ready for extraction, the owner and his labourers assemble, provided with baskets, heavy poles shod with iron in the shape of a chisel, and broad long-handled hoes. The mass of salt in the pit, which is held together by thorny branches embedded in it, is cut into sections by the iron-shod poles and is so removed. The salt having been extracted, its crystals are shaken off the thorny branches, which are then thrown aside, and it is stored in one or two oblong heaps on the bank of the pit. After the extraction of the salt, the pit, in which brine has again collected from the springs, is carefully cleaned out and thorny branches are again placed in it when it is found that precipitation has recommenced. Crop after crop of salt is thus obtained at intervals of two years, the outturn from a pit amounting to an average of 370 tons every second year.

The area of the source is about ten square miles, and the quantity of the underlying brine varies in different parts of it. The eastern half produces salt in large, heavy, solid cubes, but the brine springs are weak, the supply of brine scanty, and on this account manufacture in that part of the valley has been practically abandoned. In former times, however, work in that direction was very active, as the whole of the eastern part of the source is studded with abandoned pits which are gradually being filled with blown sand. The reason for the failure of the brine springs is not apparent. Along the line of the desert sand-hills to the eastward, there is an abundance of brine available, and it is in that direction that the pits at present worked are situated. The salt obtained from these is white and of good quality, but the crystals are smaller than those which are obtainable from the brine of the eastern half of the valley. This description of salt, however, suits the present requirements of markets better than that which used to be produced in the eastern half of the valley, so that the failure of the brine springs in that direction does not affect the trade. Pachbadra salt is considered to be one of the best of Upper India. It is white, clean, and of good crystal, and contains from about 97 to 98 per cent of chloride of sodium.

As at the Sambhar lake, so here also the salt source is held to be under the protection of a goddess mother. It is said that some years after the original manufacturer of salt, Jhanja Kharwal, settled at Pachbadra, it was revealed to him in a dream by the goddess Sambrarai (Sakambri, the consort of Shiva) that stone images of herself and of her sister Asaprai were buried under a *Jhal* tree (*Salvadora olesides*) in the centre of the salt source; that he was to exhume the images, build a temple for them and worship them; and that if he did so, the goddess would endow him and his descendants with wealth so bountifully that they would be richer than if they had been given a silver mine. Choosing an auspicious day, Jhanja dug up the images and built a temple for them close by, which stands to this day, though it has since been enlarged, and is now a more pretentious building than that which was originally erected by Jhanja. There is an inscription in the Hindi character engraved upon the image of Sambrarai which shows that the temple was built in 1514 A.D., and has been standing for 385 years. The shrine is maintained by the contributions of the salt manufacturers and the pious Hindus of other castes in the neighbourhood.

In 1878, the British Government obtained the lease of the Pachbadra salt source from the Jodhpur State for an annual payment of Rs170,000 (about £12,000), and the manufacture and sale of salt has been under the control of British officers for the past 21 years. It has been found that no improvement can be effected in the methods of manufacture which have been followed by the salt workers for generations past, as these are entirely adapted

to the peculiar local conditions. There are now 270 pits from which supplies of salt are obtained. The productive capacity of the source is great, as the salt-producing area is large and the underlying brine is abundant, but the number of pits now being worked is sufficient to meet trade demand. The pits are the property of the manufacturers, from whom salt is purchased at 2s. 3d. a ton. Payments are made in the first instance on the basis of cubic measurements of heaps as these are completed; and later, when the salt of a heap has been issued to the trade, the account is adjusted by taking the actual weight, and the manufacturers thus receive payment for every ounce of salt they produce. Unlike the Sambhar lake, Pachbadra is not dependent upon the rainfall for the production of salt, as the brine springs are perennial. Salt is obtainable even in the worst year of drought, but with a good rainfall the brine is somewhat diluted, and as a consequence of prolonged evaporation, salt forms in larger crystals under such conditions. The rainfall is extremely capricious, and climatic conditions are characteristic of the desert country. During the season of the south-west monsoon, the only time of the year when rain falls in an appreciable quantity, immense masses of cloud come up from the direction of the Runn of Kutch and pass over to the north-westward without precipitating moisture except erratically. The average annual rainfall is about 15 inches, but fluctuations are very great. During the monsoon of 1892 as much as 48 inches of rain fell, while the fall of the monsoon of 1899 was only .93 of an inch. It is this wide range in the annual precipitation of moisture which causes sterility. A sudden and heavy fall of rain produces no permanent effect, as the water speedily disappears in the sand, and the droughts which succeed parch vegetation. In addition to this, the heat at Pachbadra is very great. During the months of May and June the hard level tracts of country along the Luni river become intensely heated, and the south-west wind, which passes over these, reaches Pachbadra as a fiery gale laden with dense clouds of heated sand. Under these conditions, the thermometer has been known to rise to 122° in the shade, and this temperature, with a gale of wind blowing and the atmosphere so thick with flying sand that it is impossible to discern objects at a greater distance than about a hundred yards, is intensely felt. As a result of the great heat, the capricious rainfall and the sterility of the country, there is great difficulty in obtaining a supply of drinking water at the source. There are no wells of sweet water in the valley or anywhere in its neighbourhood, as brine is found everywhere below the surface. The town of Pachbadra is dependent upon tanks, in which the drainage of the hard soil in its vicinity collects during the monsoon. There are three tanks of the same description along the eastern slope of the valley, in which a certain quantity of water accumulates; and in parts of the bed of the valley some drinkable water is obtainable a few feet from the surface where the underlying strata are hard enough to prevent the accumulation of surface drainage from sinking to the level of the brine springs. But these sources fail as soon as the summer heat commences, and then water has to be brought in iron tanks by railway from wells on the banks of the Luni river, ten miles distant.

Pachbadra salt is sold at 2s. 10d. a ton; and, as at the Sambhar lake, for the further payment of sevenpence a ton, the British officers at the source undertake to despatch salt by railway to traders carrying on business in areas of consumption. As the source is situated in the desert, the trading community avails itself very largely of this convenience, and practically the whole of the salt removed yearly by railway is bagged and despatched under arrangements made by British officers. During the 21 years that the source has been worked by the British Government, about 465,000 tons of salt have been produced, and the present yearly trade of the source amounts to about 30,000 tons. Before the construction of a railway, Pachbadra was a favourite resort of the wandering carriers and traders called Banjaras. At the commencement of each monsoon season, as soon as water and fodder became available, these men used to leave the Aravali mountains and travel over the sterile country westward to the Pachbadra salt source with their droves of pack bullocks. At that time practically the whole of the trade of the source was in the hands of Banjaras, who used to arrive every year with thousands upon thousands of pack bullocks. The town of Pachbadra owed its rise to these annual visits of Banjara carriers, as the bankers who settled in it carried on business with the leaders of the different parties and trade of all descriptions resulted. But with the extension of a branch of the Jodhpur and Bikaner railway to Pachbadra, the Banjara trade has declined greatly, and now comparatively few of these wanderers visit the source. At present, all but a small percentage of the salt sold is removed by railway, and the Banjara trade is practically at an end. Pachbadra salt is widely distributed and the areas within which it is consumed include Rajputana, Central India, the Central Provinces, and the North-Western Provinces and Oudh.

Though in the summer season the valley of the salt source is a scene of desolation, yet it is preferable to the dreary desert which lies to the westward of it. The subsoil moisture is saline, but owing to its existence the roots of the grass in the sandy surface retain some little vitality, and at the commencement of the summer the desert rats migrate to the valley in millions to feed upon these roots. Numberless snakes accompany these rats in order to prey upon them; snakes of all descriptions, from the hideous black cobra to the more harmless varieties. The most dangerous snake at the source is the *Echis carinata*, a fierce but sluggish viper, whose poison causes a lingering and horrible death from hemorrhage within the space of about three days. Other snakes, even the cobra, are timid, and will move away rapidly at the least sound. The small *Echis* does not do so, but coils itself up when it hears a footstep and strikes at the foot (generally the instep) of a passer-by if he happens to come within reach. The colour of the *Echis* is a dull grey, and it is difficult to see the snake at night when it is coiled up on the sand. The native shoe leaves the instep bare, and a number of men suffer annually from the bite of the *Echis*. In the case of persons treated in the hospital at Pachbadra, the subcutaneous injection of strychnine has been found to be a cure, and deaths from the poison of the *Echis* do not now occur when so treated. The people of the desert drink melted butter as a remedy and it is said that this often effects a cure.

The salt source of Didwana is situated in the State of Jodhpur and at a distance of about 40 miles north-west of the Sambhar lake. Leaving the town of Nawa on the north-western shore of the lake, the heavy road over the sand leads for fifteen miles to the town and fort of Kuchaman. About half way, a saline depression exists at the village of Sargôt and at the foot of one of the ridges of the Aravalis. Some water collects in this during the monsoon season and leaves a strong saline efflorescence on its evaporation during the dry months of the year. At Kuchaman itself, another and larger saline depression exists, which is annually filled with water from the drainage of the spurs of the Aravalis under which it lies. The depression is a miniature of the Sambhar lake in

its appearance and characteristics, except that but very little salt forms in it, and that little is so inferior as to be not worth collection. The Chief of Kuchaman is one of the principal Barons of the Jodhpur State, and his town and fort are extremely picturesque. The fort is built on the summit of an isolated conical hill, and the town nestles beneath it at the foot of its southern face. An abundance of sweet water is found not far from the surface, and the strong fort on the summit of the hill, the town at its foot, and groves and green fields around form a pretty picture in the midst of a sterile country. The bare and arid peaks and ridges of the Aravalis immediately to the south-west, and the barren-looking country to the west and north, enhance the picturesqueness of the scene. From Kuchaman the road runs north-west by north 25 miles to Didwana and thence onwards into the heart of the desert. At first the sandy undulations of the country are low, but as Didwana is approached they grow steeper, until at last from their summits the peaks of hills are discerned in the distance over the sea of sand. A few miles further, the country slopes slightly north-westwards and the salt source and its surroundings are seen. The source lies in a valley about 3½ miles in length by 1½ miles in breadth, running south-west and north-east, and bounded on its western side by an isolated spur of the Aravalis.

The town of Didwana lies to the north of the depression and at its north-eastern end. Considering the aridity of the country, it is of considerable size, its population numbering about 11,000; but before the railway was constructed to Bikaner the high road to the desert, which passes through it, was much frequented, and the existence of the salt source enhanced its importance and increased its business. The antiquity of the town appears to be considerable, and it is said to have been in existence about 2,000 years. It is related that on one occasion, when an excavation was being made, a stone idol was found bearing the date of Sambat 252 of the Hindu era, equivalent to 195 A.D. In digging the foundations of new houses and wells, articles of pottery have been found twenty feet from the surface. The general level has gradually risen above a very ancient temple in the town until only the top of its spire is now visible.

The valley in which the salt source lies has the appearance of having been the bed of a river. To the north-east and south-west it has apparently been overwhelmed with sand, but its continuation in both directions can be distinctly traced. The prevailing wind is from the westward, and the depression as it exists has evidently been saved from the advancing waves of sand by the spur of the Aravalis in that direction contiguous to it, which has served as a protection. Local tradition is to the effect that the valley was once a river which flowed from the north-eastward and which became choked with sand higher up in its course. The western edge of the valley rises somewhat abruptly, but to the eastward the general level slopes gradually towards it. About half a mile of each end of the valley is cut off from the central portion by earthen embankments thrown across, and these serve to prevent the drainage of either end from flowing into the central section. This central portion forms the salt source and is about 2¼ miles in length. The bed of the source is composed of black tenacious mud, very similar in appearance to that of the Sambhar lake, and a stratum of strong brine underlies it, varying in density from about 20° Beaumé to very nearly the saturation point. Some water collects annually in the source during the season of the monsoon rains, but this is rapidly evaporated during the dry months, leaving a thin crust of salt over a small area in its centre. Except during the rainy season, the bed of the source is dry and covered with a profuse efflorescence composed of sodic chloride, sulphate, and carbonate.

The method of manufacture is exceedingly simple. Wells are dug in the bed of the source until the brine springs are reached at a depth of about 12 feet from the surface. The upper stratum passed through is composed of the black mud of the source, soft towards the surface but gradually hardening to the consistency of soft shale at a depth of about 10 or 12 feet. The brine springs occur in a bed of calcareous matter below the stratum of black mud. When this lower stratum is reached, the inrush of brine becomes so strong that further excavation becomes impracticable, and a heavy beam shod with iron is then used (it is lifted by a number of men and allowed to fall by its own weight) to pierce the brine stratum as much as possible. As soon as the spring has been effectually tapped in this manner, the brine rises in the well with a swirl, emitting bubbles of offensive sulphuretted hydrogen gas as it does so. The emission of the gas indicates that the spring has been reached and that a constant supply of brine can be safely calculated upon. The brine rises about six feet above the spring level and the supply is inexhaustible. The wells are roughly lined with wood for a few feet from the surface and most of them have been worked for centuries. They have to be cleaned out occasionally to clear the spring orifice, but that is all. After the excavation of a well, the next step is the construction of one or more solar evaporation pans of a rectangular shape near it. These are prepared by removing the mud of the surface to a depth of from six to twelve inches, and roughly levelling the exposed area. Brine is then lifted from the well by a weighted pole and bucket, and is allowed to flow into the pan. At first, the bed of the pan absorbs very nearly the whole of the brine, and for a few years the outturn of the pan is small in quantity, and it is discoloured by the black mud of the pan bed. But gradually large crystals of a form of sulphate of soda form in the mud, and these increase in number year by year until their accretions form a solid and hard bed; so hard that a pickaxe would be needed to break through it. In some of the pans, these crystals form a stratum about two feet in thickness. When its bed has consolidated in this manner, a pan is capable of producing clean white salt in large quantity. Brine is run into it from the well to a depth of from two to three inches, and as salt forms it is scraped up into low ridges with a wooden instrument formed of a section of plank attached to a long handle. This ridging of the salt is steadily carried on from the time precipitation first commences until the crop is ready, the position of the ridges being moved from day to day so as to immerse all the crystals in the brine daily. This is necessary, as the brine is of so great a density that salt forms in the channels along which it flows from the wells, and when it enters the pan precipitation occurs almost immediately and, of course, in very small crystals. The hardness of the beds of the pans assists rapid evaporation, as during the summer months they become so heated that the manufacturers cannot enter a pan with bare feet after about midday. By collecting the salt in ridges and moving these about in the brine, the size of the crystals is increased and many of them adhere together in lumps about the size of small marbles. When care is taken in manufacture, a large proportion of the crop obtained from a pan is composed of these agglomerations, each of which consists of a number of small cubes of salt joined together by salt brine. When it is found that the salt in a pan has sufficiently developed as regards the size of its crystals, and such a quantity

has formed as to render the daily moving of the ridges laborious and difficult, it is collected in heaps in the pan and then removed to a place of storage on its edge. Didwana salt is white and clean, but owing to the high specific gravity of the well brine and rapid precipitation, its crystals are always small. It contains from 95 to 98 per cent of chloride of sodium. The salt pans are about 80 feet square and are each capable of producing a crop of from 10 to 12 tons of salt every 15 days. There are two clusters of factories; one of 222 pans and 46 brine wells on the southern edge of the depression, covering an area of about one half by a quarter of a mile; and the other on the western edge, where 25 pans and 7 brine wells are scattered along a line of about 400 yards.

The greater number of the salt factories have been in existence for centuries. But few pans and wells have been constructed in recent times, and there are no traces of old works to be seen, except a few at the north-western end of the source, which were abandoned about 22 years ago in view to the concentration of manufacture at its south-western end, where the brine is more abundant and of better quality. It is said that manufacture has been carried on by the present class of workers for about 400 years, and there is no tradition of salt having been produced prior to that period. But in 1878 an experimental well was sunk on the eastern edge of the source on a somewhat high level, and an excavation laid bare the mouth of an ancient well at a depth of about 8 feet from the present surface level. This well was about 3 feet in diameter and 10 feet in depth; its bottom was just above the brine springs and a beam of wood was lying across its mouth. It was quite different to the wells at present worked and there is no tradition of salt having been produced so high up on the edge of the depression. It was sunk when the level of the source was 8 feet lower than at present, and it must have been in use at a very remote period in the past. Salt manufacture at this source is probably of great antiquity.

In 1878, the British Government obtained the lease of the Didwana source from the Jodhpur State for an annual payment of ₨200,000 (about £13,000), and it has been worked by British officers for about 21 years. During this interval no change has been made in the methods of manufacture, as it has been found that those followed by the *Deswals* (as the manufacturers are called) are best adapted to local conditions. There has been no extension of work, as the factories which were existing have been capable of producing as much salt as the trade requires. Indeed, much more than is needed can be produced, and work is confined to about two or three months in each year. The supply of brine is abundant and inexhaustible, and in the dry climate of the desert, manufacture can be carried on continuously for nine months in the year. The rainfall has no effect upon the salt producing capabilities of the source. The fall is confined to three months of the monsoon (July, August and September), and though the average is about 15 inches, yet the yearly quantity varies greatly, fluctuating from as much as 23 inches to as little as 3 inches.

During the past 21 years, about 300,000 tons of salt have been produced at this source. Payment is effected in the same manner as at the Sambhar lake. When salt is extracted from the pans, it is placed near them in small pyramids containing from three to five hundred-weight; the quantity in each of these is estimated by means of a graduated rod, and each manufacturer is paid at once for the salt he has produced. After estimation, the salt is collected in heaps near the pans, and is finally conveyed in carts to storage grounds above the bed of the source, and is stored in large oblong heaps each containing as much as 4,000 tons. There is a storage ground near each of the two clusters of factories; one on the western and the other on the eastern edge of the depression. Though the source is not liable to be flooded except in its centre, yet the mud of its bed becomes extremely viscid with the least moisture (by which it is readily affected, owing to its salinity), and salt has to be removed to the sandy edge of the depression for the convenience of the trade. It has already been remarked that the mud of this source is very like that of the Sambhar lake, and it is liable to become heated to a high temperature in a similar manner. Towards the end of May, 1877, when the writer was in charge of Didwana, an unusual fall of rain occurred, flooding the centre of the source, and followed by intense heat. One of the native establishment attempted to cross the depression in the heat of the day, at a narrow part, where the mud and water were less deep than elsewhere, and up to a little below his knees. When he got about half-way across he found that the soft mud was scalding hot and shrieked for help. His comrades on the hard ground near the edge dare not venture into the mud and urged him to pass through as quickly as he could. He struggled through the heated mud with great difficulty, and fell exhausted on the shore with his feet and legs terribly scalded. He was carried to hospital and some months elapsed before he was able to walk.

The cost of manufacturing Didwana salt and storing it for sale on the edge of the depression is tenpence a ton, and it is sold at the rate of 1s. 8d. a ton. The railway has not been extended to this source, and the nearest railway trading station is 40 miles distant at Nawa on the Sambhar lake. The trade of the source amounts to about 12,000 tons annually. Didwana salt is consumed in the north-western portion of the Jodhpur State, in the Bikaner country to the north, in the Jaipur State to the eastward, and a little is exported to the Kotah and Bundi States south of the Sambhar lake. The principal trade is with the eastern districts of the Panjab, to which the salt is conveyed partly across the intervening desert country and partly by way of the Sambhar lake and the railway thence. Some is also consumed in the submontane districts of the North-Western Provinces. Camels are principally used for the removal of salt from the source, and in the desert country these animals are the cheapest and most expeditious means of carriage. Salt for the surrounding country is carried away in the small carts of the desert, and during the monsoon months a few Banjaras visit the source when grass and water are available for their pack bullocks on the trade routes leading up from the southward. Though the manufacture of salt is not affected by the rainfall, yet a failure of the monsoon affects the trade of the source prejudicially, as during seasons of drought (common in the desert country) water and fodder are scarce on the trade routes.

The three sources which have been described (Sambhar, Pachbadra and Didwana) are the principal salt-producing localities in Rajputana. There are two others at which salt is manufactured; Lonkaran Sarr in the Bikaner State, and Kanôd in the State of Jaisulmer. These are worked by the officials of the States in which they are situated.

The source of Lonkaran Sarr is situate in the heart of the southern desert and about 50 miles to the north-

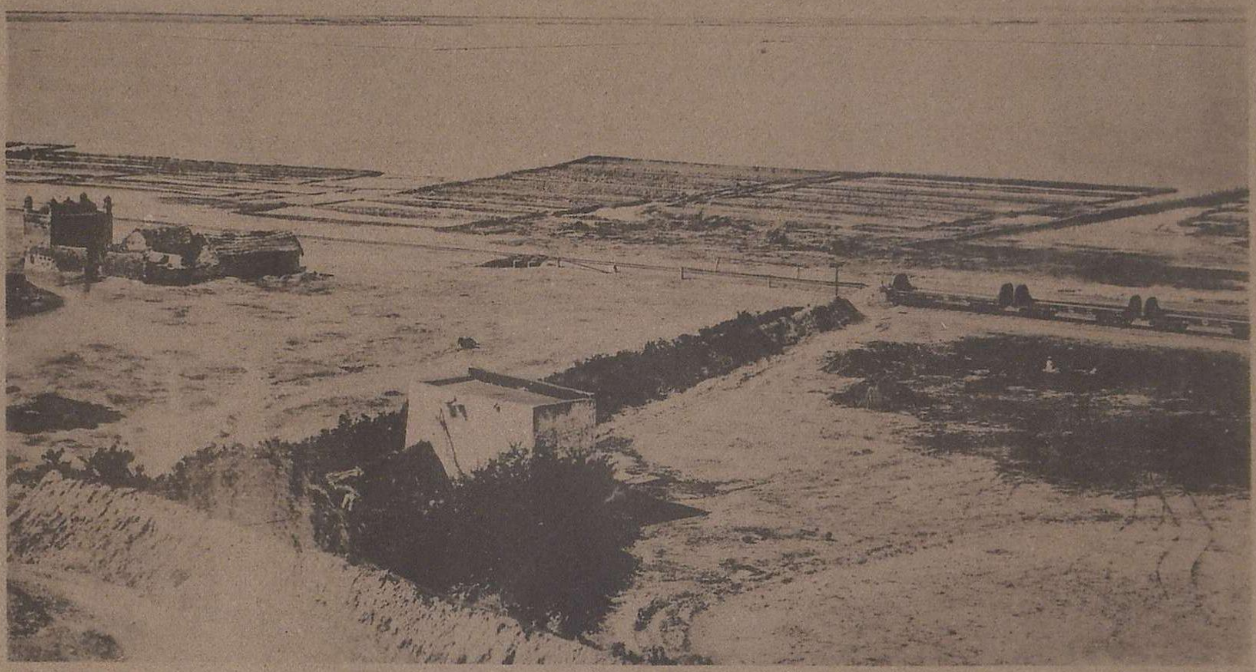
ward of the city of Bikaner. A depression exists in the desert, about two miles in length by one and a half in breadth, and below the bed of this, springs of saline brine are found at a depth of about 14 feet. The surface of the depression is sandy with the underlying stratum of tenacious dark grey clay, below which the brine is found. Excavations in the shape of pits are made down to the spring level, and the brine so reached varies in density from 13° to 20° Beamé. The salt is produced in large solar evaporation pans of a rectangular shape and about 50 feet square. These are constructed by removing the sandy surface of the depression and excavating the required area in the clay substratum to a depth of about 12 inches. Two brine condensers are constructed in connection with each pan and on a somewhat higher level. Brine is lifted from the brine pits by the aid of a weighted pole and bucket and run into the condensers, from which it is allowed to flow into the pans. A crop of salt is obtained from a pan in about 10 or 12 days during the summer months of the year, and the cost of manufacture is about 3s. 4d. a ton. The salt is of small grain and somewhat discoloured by the clay of the beds of the pans and blown sand, but its quality is fairly good, as it contains about 93 per cent of chloride of sodium. The manufacture is very limited, only about 1,100 tons of salt are produced annually, and consumption is restricted to the desert country of the Bikaner State.

The Kanôd source is situated in the centre of the Jaisulmer State, in the southern desert, and in country even more desolate than that of Bikaner. The writer visited this source during the summer of 1877, and has a very vivid recollection of the journey. Starting from the south-eastern corner of the State, the route lay at first over sterile stony country and then over enormous sand-hills. Desert villages, clusters of a few small huts constructed of stems of the *Asclepias Gigantea* and desert grass, were met with at intervals of 20 and 25 miles, and guides had to be obtained to travel from point to point. In that country, no man starts abroad without a water-skin slung over his shoulders; even the camel herds, who do not move far from their villages, carry these skins. Water is scarce and brackish, and wells are 300 feet and more in depth. The salt source lies at the head of a rocky valley which separates the stony desert from the sandy and waterless one which extends northward for about 100 miles to the Bahawalpur State on the river Sutlej. Brine underlies a low-lying and barren area of about a mile square, and at a depth of about 10 feet. Pits are dug to reach the brine, which is lifted by the weighted pole and bucket. A few inches below the surface of the source, a bed of bluish, impermeable clay is found, and solar evaporation pans are excavated in this. Brine is exposed to evaporation in these pans, and a small-grained, white salt is obtained. The desert country is so sparsely peopled that only about 500 tons of salt are produced annually.

Besides these sources at which manufacture is at present carried on, there are many other depressions in Rajputana at which salt can be produced. None of these are of the type of the three principal sources, but all of them have a substratum of brine within workable distance of the surface. One of these localities lies in the Jaipur State, at the villages of Kachôr and Rewasa and at a distance of about 30 miles north-west of the Sambhar lake. North of Didwana, and at a distance of about 20 miles from that town, there is a saline depression named Chapar Tal, near the town of Sujangarh in the Bikaner State. Westward, and in the extreme north-western corner of Jodhpur territory, there is a very large depression about 15 miles from the town of Phalodi, called the Phalodi salt source. This source is about 5 miles in length by 3 miles in breadth, and brine underlies it at a depth of about 9 feet from the surface. Large quantities of salt could be readily produced at this source. It was worked by the British Government for some years, under a lease from the Jodhpur State, but manufacture has ceased for some time past as it was found to be unprofitable. The source is distant about 100 miles from a railway, and as the country around is desolate and very sparsely populated, the smallness of the demand prevents it from being profitably worked. Added to this, the average annual rainfall is only about 9 inches, with great fluctuations, and there is great difficulty in obtaining a sufficiency of drinking water. About 50 miles south-west of the Phalodi salt source, another large saline depression exists near the town of Pokaran in the Jodhpur State. This is about four miles in length by two in breadth, and brine underlies it at a depth of about seven feet. Salt has been manufactured in the past, but the position of the source in a desert country and at a distance of about 100 miles from the nearest railway prevents it from being profitably worked.

Finally, the Luni salt source may be mentioned. The Luni river has already been described. At its mouth, where it enters the Runn of Kutch, a large delta has been formed by the annual floods, with numerous deep channels. During the dry months of the year, when the bed of the main stream is perfectly dry, brine percolates into these channels and salt of good quality forms in thousands upon thousands of tons annually, only to be swept away when the river comes down in flood during the monsoon. Salt also forms in a sheet over the end of the Runn itself when the wind causes an accumulation of brine at its head. An attempt was made many years ago to utilise these collections of spontaneous salt, but it had to be abandoned as there was not a profitable demand. The country around is desolate and thinly populated, and drinking water is scarce. The nearest railway station is about 80 miles distant, with a difficult and desert country to traverse. The Runn is an immense level expanse of mud extending as far as the eye can reach. Looking south-westward from the mouth of the Luni river, the peaks of the hills which lie on its western shore can be seen 50 or 60 miles away appearing over the sea of mud as they would over an expanse of water. The immense sand-hills of the desert appear to the westward, while all around is desolate and drear. The desert antelope and gazelle are to be met with about the head of the Runn, and the wild ass roams along its shore. The scene is desolate beyond description.

Illustrated by 59 Views, etc., on 17 Plates (48—64).



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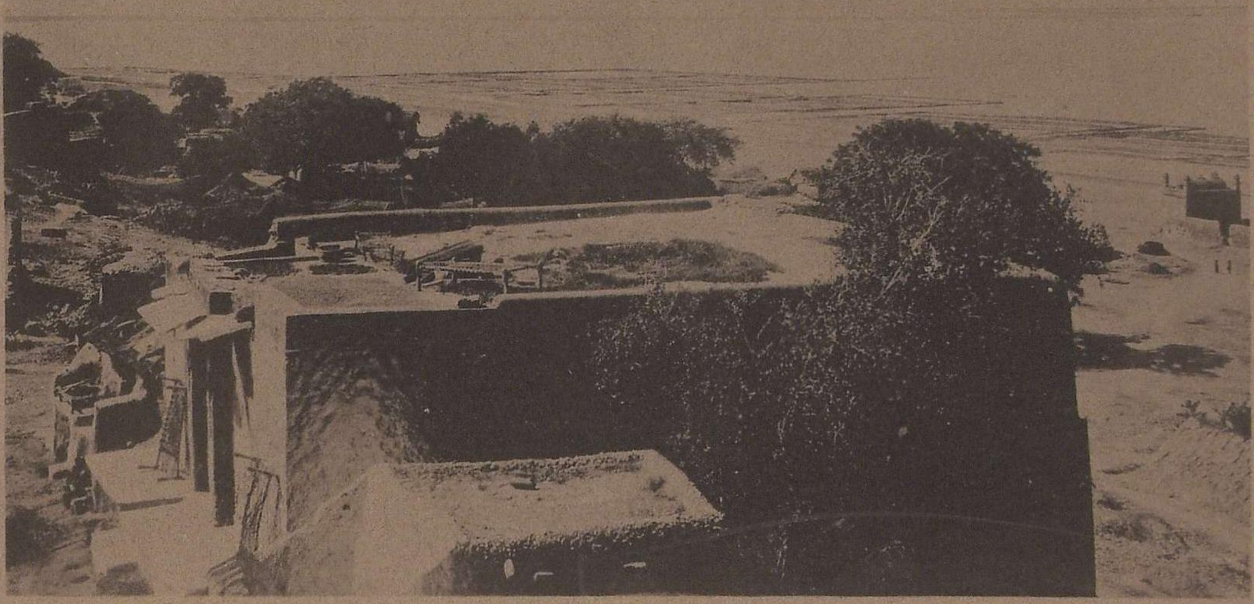
SAMBHAR SALT LAKE.

48 { 1. View of the lake looking westward from the town of Sambhar.
2. Another view of the lake.



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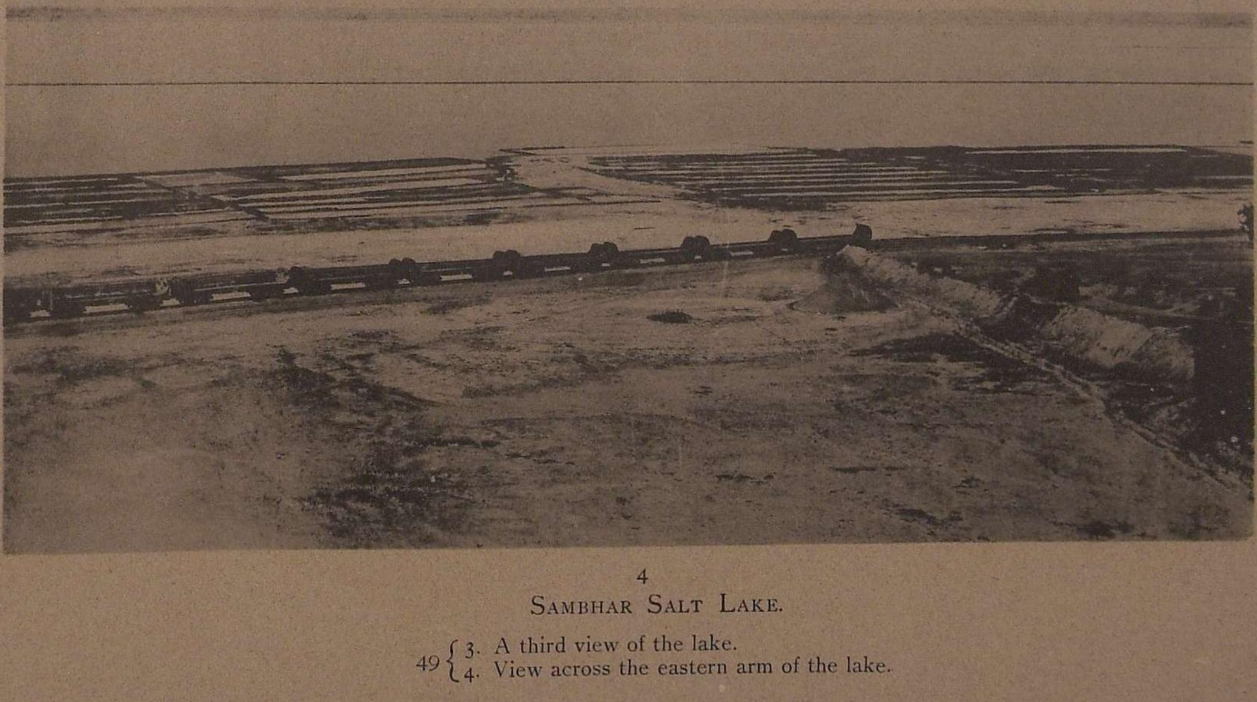


4

SAMBHAR SALT LAKE.

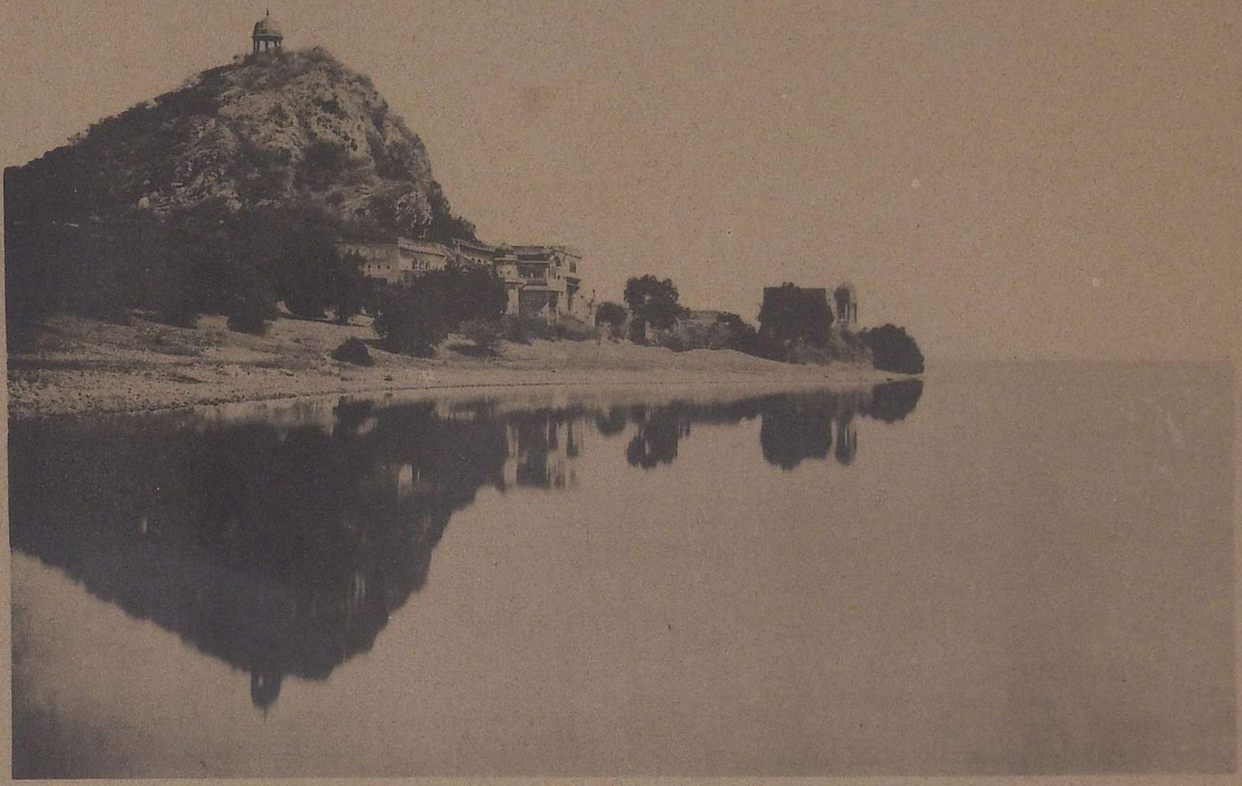
49 { 3. A third view of the lake.
4. View across the eastern arm of the lake.

5

6

SAMBHAR SALT LAKE.

50 { 5. View across extremity of the eastern arm of the lake.
{ 6. Hill on south-western shore, the dry bed of the lake in the foreground.



7

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SAMBHAR SALT LAKE.

51 { 7. Mata Pahar, the hill of the mother, the goddess mother Sakambri.
8. Collection of salt in an evaporation pan of a Kyar near the town of Sambhar.

9

10

11

SAMBHAR SALT LAKE.

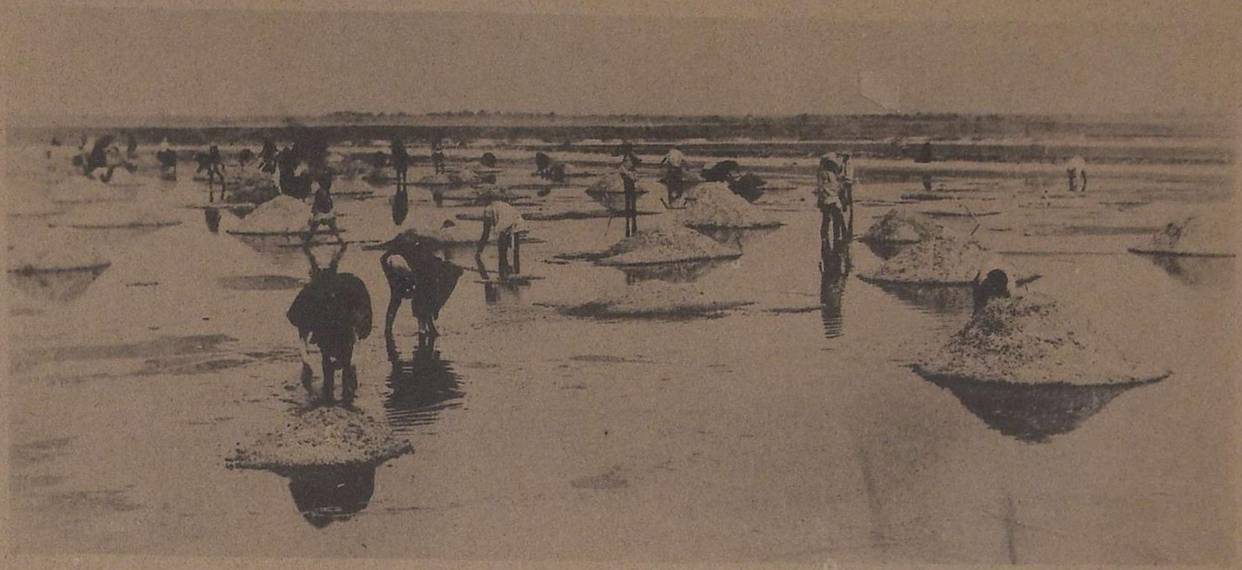
52 { 9. Another view of work in a Kyar.
10. A third view of work in a Kyar.
11. A fourth view of work in a Kyar.

12

13

SAMBHAR SALT LAKE.

53 { 12. View of part of the Kyar at Nawa.
{ 13. Centrifugal pump and engine at the Sambhar Kyars.



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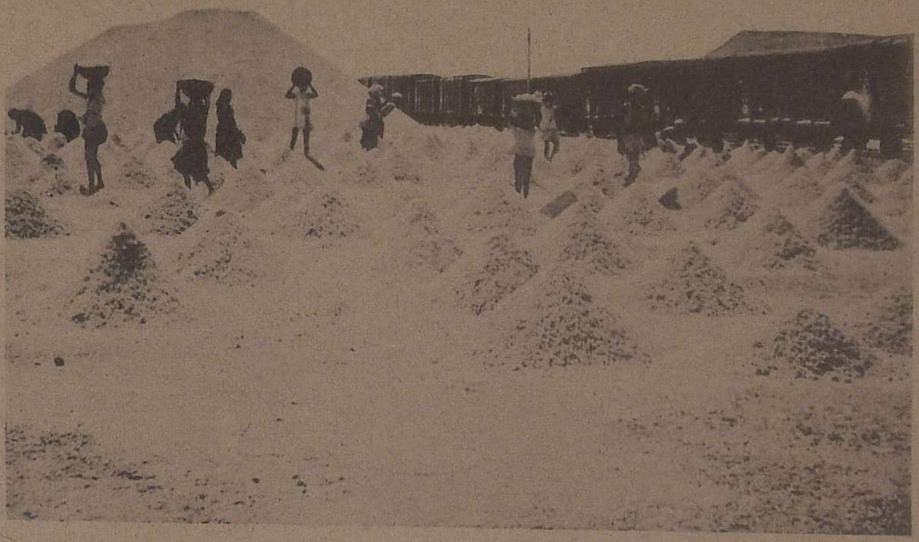
16

SAMBHAR SALT LAKE.

54 { 14. Collection of spontaneous salt from the bed of the lake.
15. Another view of the collection of spontaneous salt.
16. Preparing salt for estimation.



17. Salt being prepared for estimation.

18. Estimation of salt on a storage platform of a Kyar.

55.—SAMBHAR SALT LAKE.

19

20

SAMBHAR SALT LAKE.

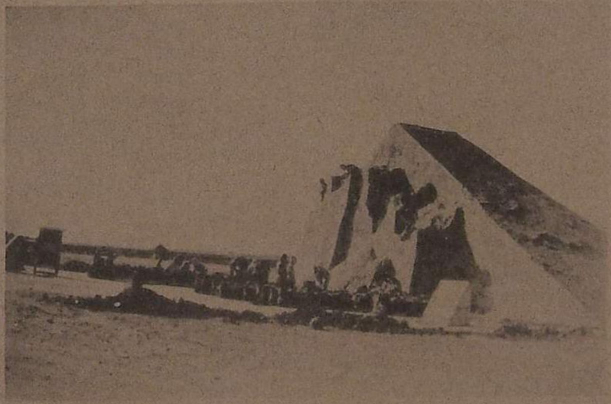
56 { 19. Estimation of salt of evaporation pans on the lake edge, the town of Sambhar in the left background.
20. Salt being stored in a heap.

21. Labourers carrying salt.

22. Salt being stored.

23. Another view of salt being stored.

26. Bags being filled with salt.



27. Bags being filled with salt.

28. Bags being filled with salt.

57.—Sambhar Salt Lake.

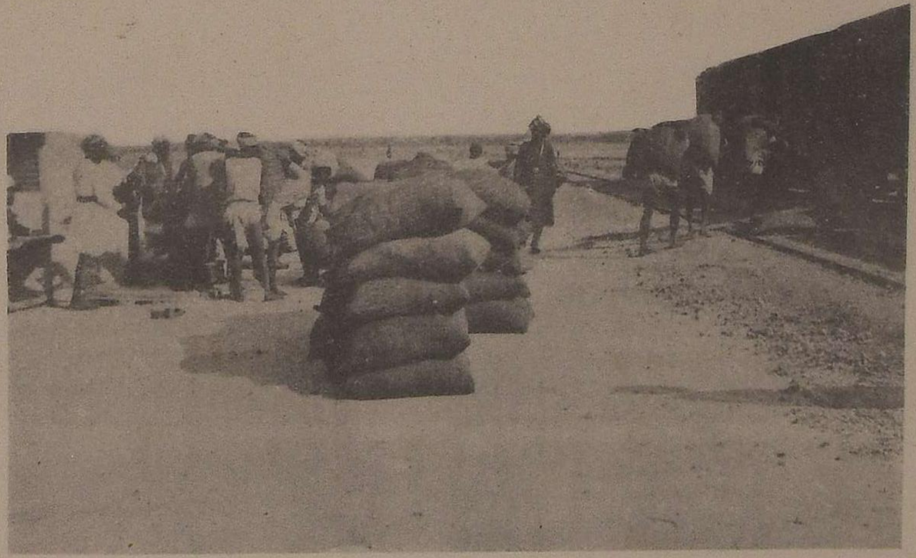
24

25

SAMBHAR SALT LAKE.

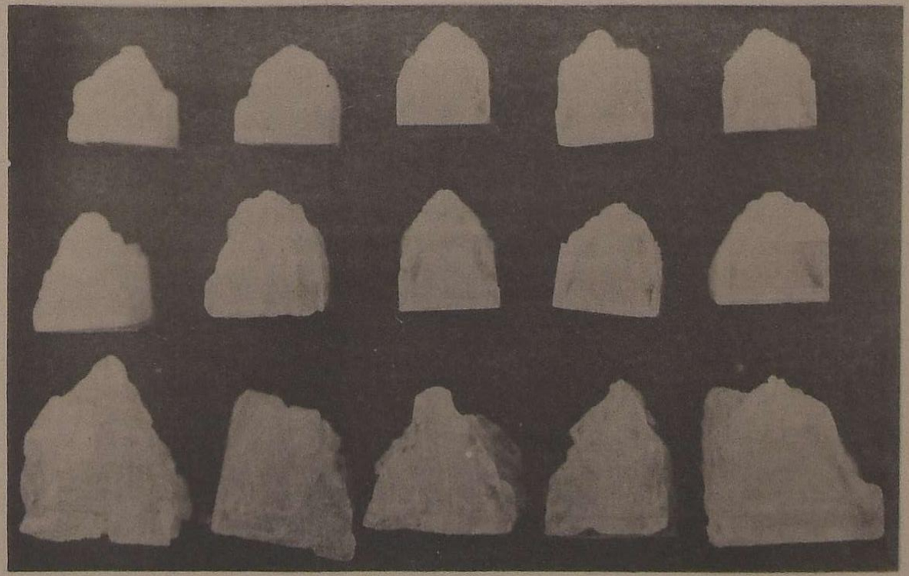
58 { 24. Heaps of salt on a railway siding at the Sambhar Kyars.
25. Bags being filled with salt for despatch to traders.

29. Salt being weighed and loaded in railway wagons

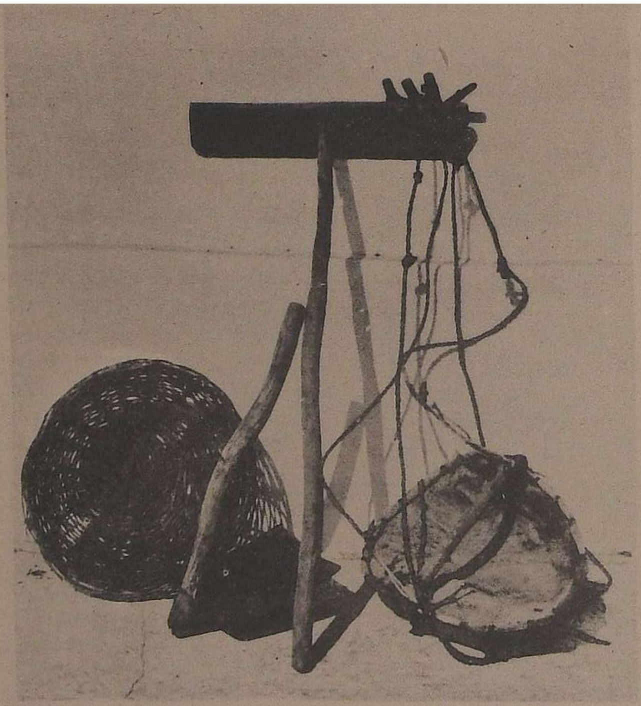


30. Railway wagons being loaded with salt.

31. Railway train loaded with salt.



32. Crystals of Sambhar salt.

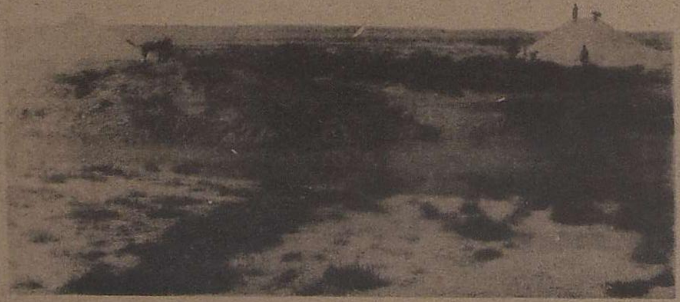


33. Implements of salt manufacture.

35. View of the town of Nawa.

34. Settlement of salt officers near the town of Sambhar.

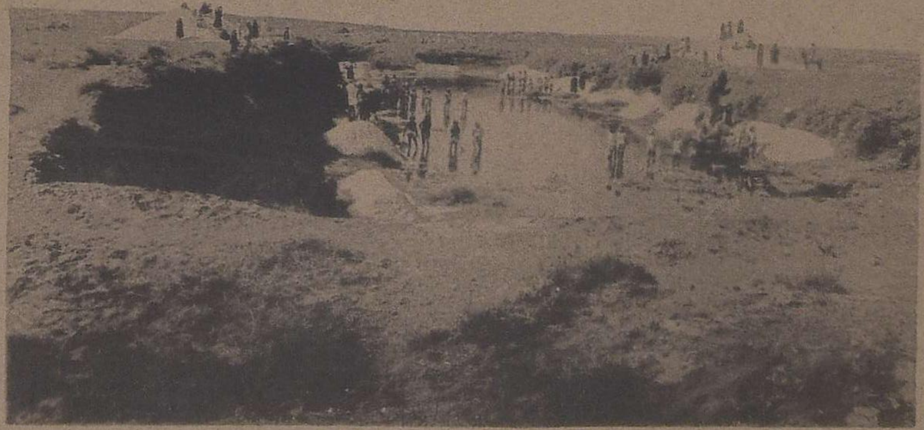
60.—Sambhar Salt Lake.



40. View of a salt pit, with heaps of salt on its banks.

43. Crystals of Pachbadra salt.

36. Salt officers' houses near the town of Nawa (Sambhar).



39. Collection of salt, from a pit.

37. View of the salt source, looking south-westward.

38. Another view of the source, looking southward.

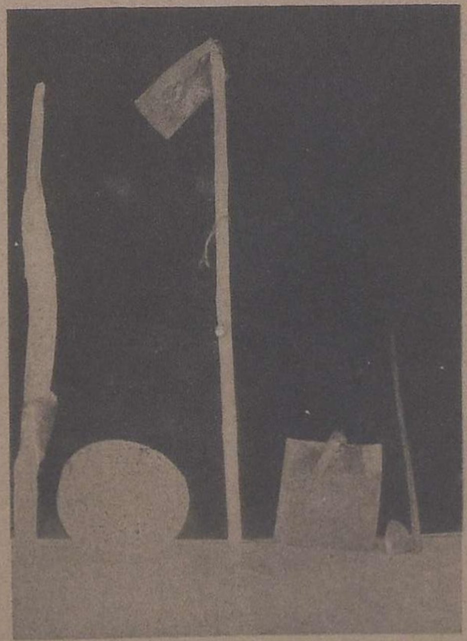
61.—PACHBADRA SALT SOURCE.

44. Salt being sent from a pit to the railway station.

47. Salt manufacturers of Pachbadra.

45. The railway station; salt being despatched by railway.

46. Salt being weighed out to Banjara carriers.



41. Implements used in salt manufacture.

42. Salt adhering to a branch of *Morali*, Lycium Europeum.

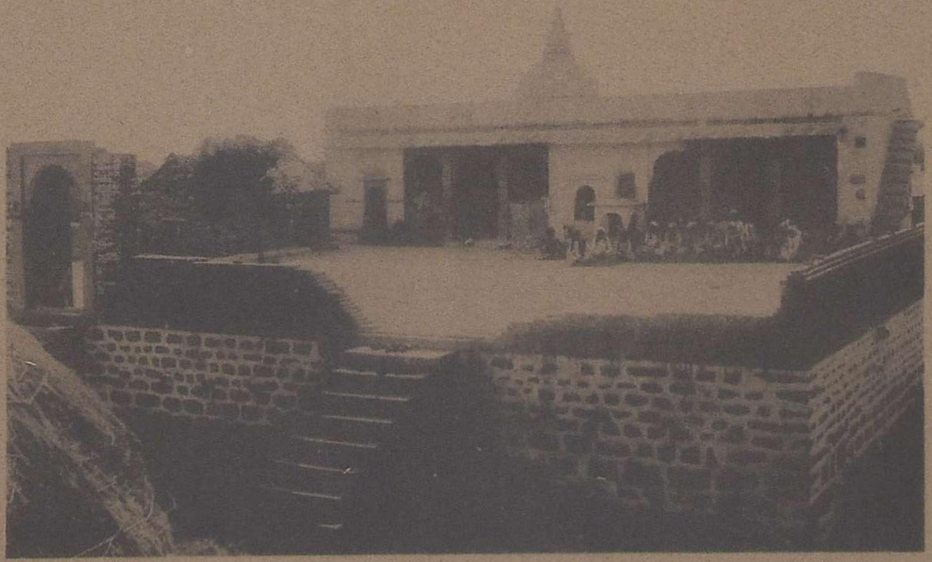
62.—Pachbadra Salt Source.

49. View of salt source, looking south.

50. Another view, looking west.

52. View of storage ground.

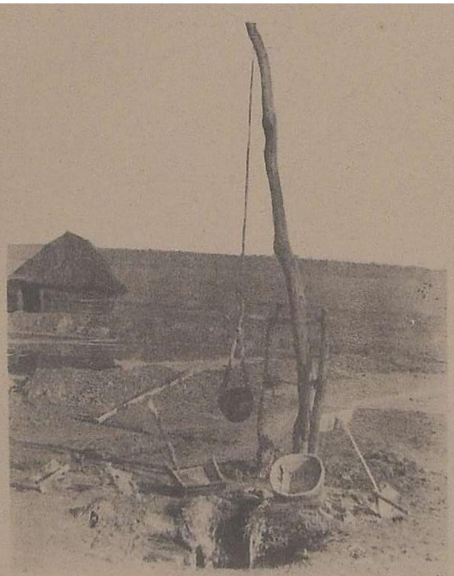
51. View of a salt factory.



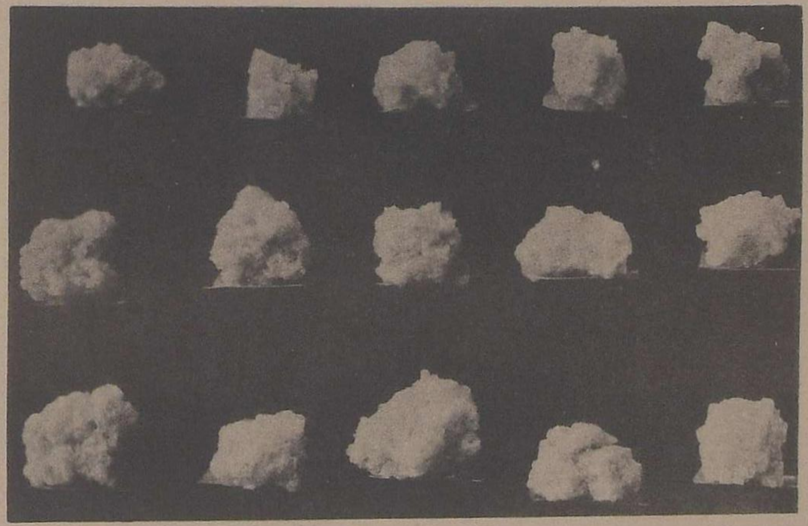
48. Temple of the goddess mother Sambrarai (Pachbadra).

63.—Didwana Salt Source.

55. Salt manufacturers of Didwana.



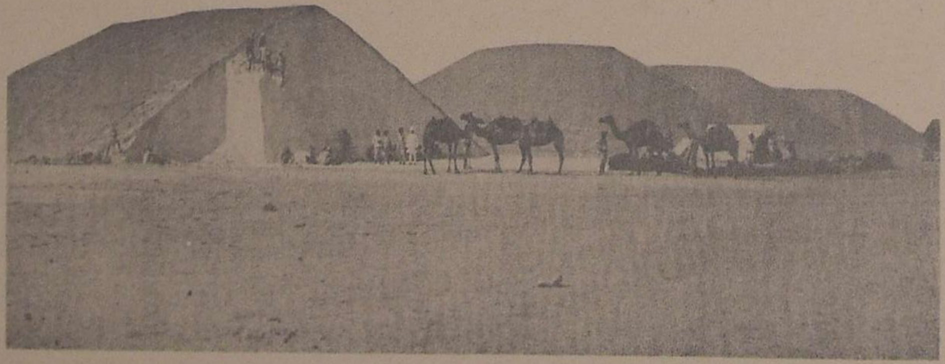
56. Brine well.



57. Crystals of Didwana salt (magnified).

54. Salt being weighed out to traders.

58. Officers' house.



53. Bags being filled with salt.

59. View of the town of Didwana.

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